

SECONDARY STRESSES IN 112 FOOT
RAILROAD PONY TRUSS

BY
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S. ISAACSON

ARMOUR INSTITUTE OF TECHNOLOGY

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Appelbaum, A.
Secondary stresses in 112
foot railroad pony truss



SECONDARY STRESSES IN 112 FOOT
RAILROAD PONY TRUSS ²¹²⁰³
₃₅

A THESIS

PRESENTED BY

A. APPELBAUM AND S. ISAACSON

TO THE

PRESIDENT AND FACULTY

OF

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IN

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Preface.

The analysis of Secondary Stresses, although such stresses were recognised by engineers in their designs, has been considered a very laborious operation and until recently their computation was deemed unnecessary in most cases.

The purpose of this thesis is to present a systematic method for the solution and a convenient arrangement of the calculations, and also to show the importance of secondary stresses in trusses of relatively small proportions.

The authors have not attempted to introduce or apply any new theory. For the derivation of the formulae, the reader is referred to an excellent treatise on the subject by Johnson, Bryan, and Turneaure "Modern Framed Structures" - Part 2.

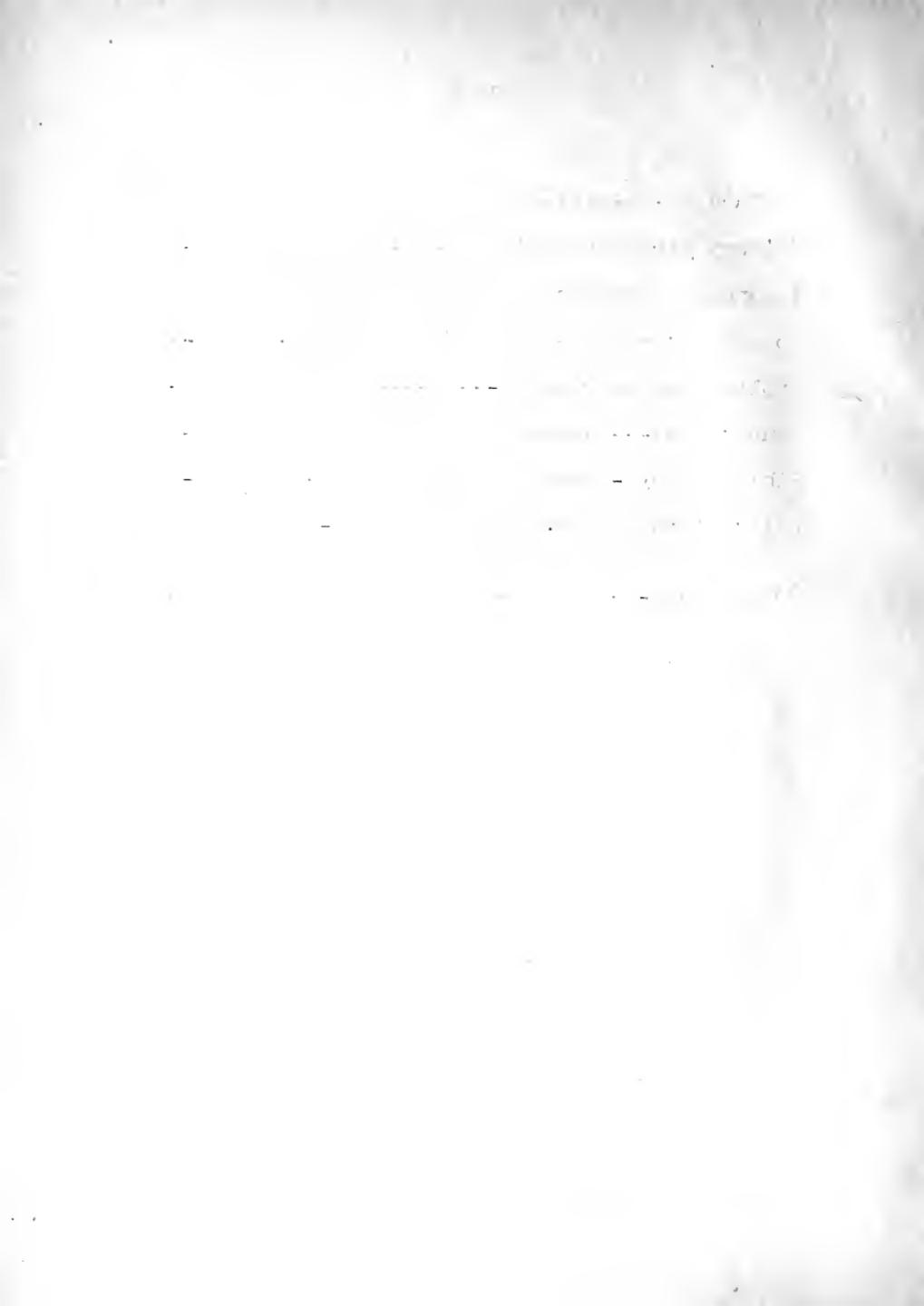
The authors have chosen what they believe to be a typical problem, and it is hoped that the present work will prove of benefit to those desirous of acquiring a working knowledge of the subject.

May 25, 1921. Chicago, Ill.

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Pony Truss -----	Plate



Primary and Secondary Stresses Defined.

In the analysis of stresses in a truss it is usually assumed :

(1) The joints lie in the gravity axes of the members.

(2) All external loads and weights of members are applied at the joints only.

(3) All members are free to turn at the joints.

(4) All members are straight, and remain straight after the loads are applied.

The stresses resulting from a determination based on these assumptions are called " Primary " or direct stresses.

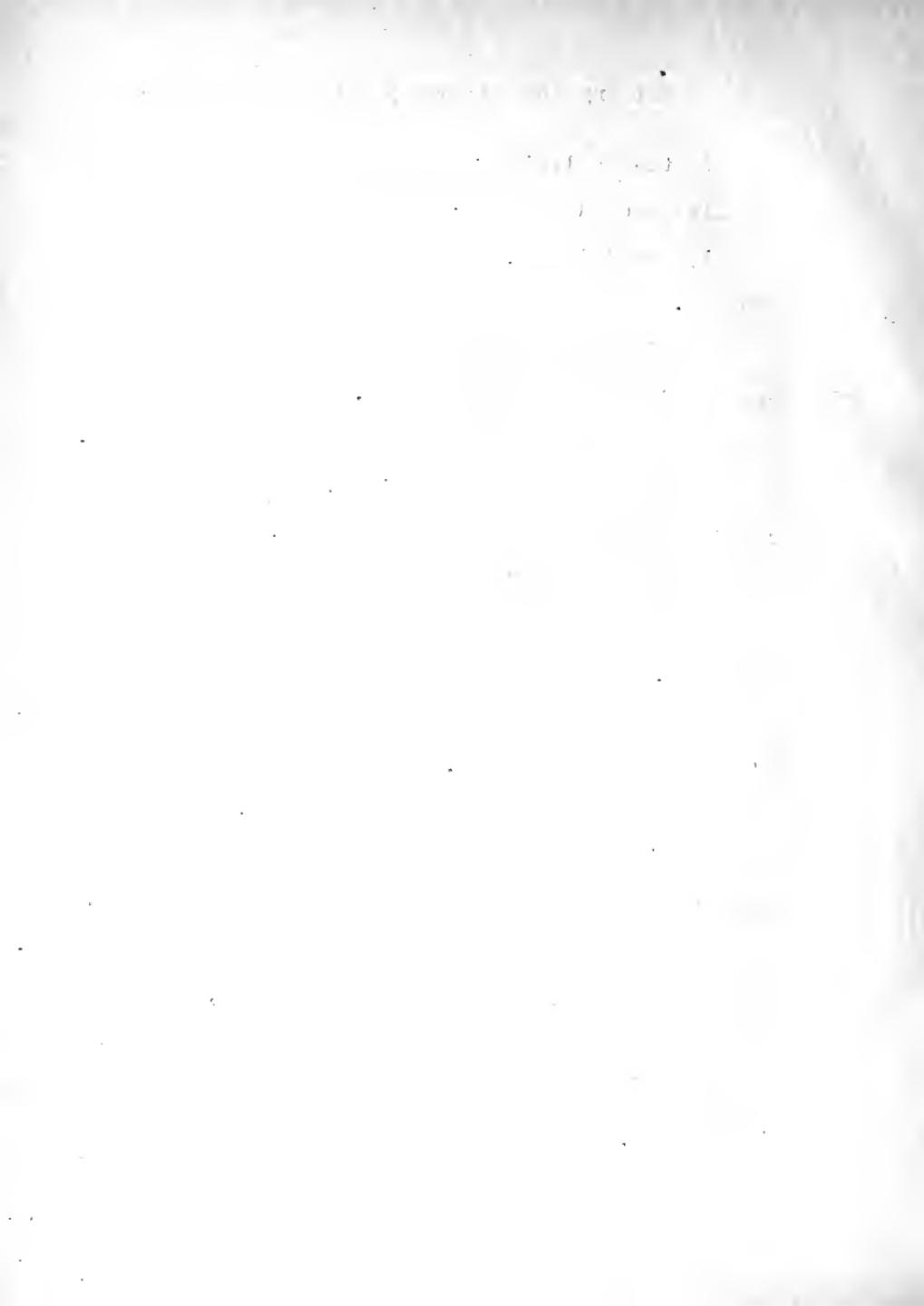
That these assumptions are not realized in practice is easily apparent.

(1) The joints are often eccentric.

(2) The weights of the individual members are carried to the joints by the members acting as beams.

(3) The members are not free to turn at the joints.

This must be true in riveted connections, and is true to a considerable extent even in pin connections, because there is always friction between the pin and the member.



(4) The members themselves are not straight and do not remain straight after the loads are applied. Since the members are rigid at the joints, a change in relative position of the joints due to the primary stresses will introduce a single or double bending in the member.

The stresses resulting from this bending due to the rigidity of the joint connections and the other factors mentioned are called " Secondary Stresses."

It has been found that the most important of the secondary stresses are the bending stresses, and consequently an analysis of the other secondary stresses has been omitted.

Formulae.

Calculation of the changes of angle in any triangle in terms of the changes in the lengths of the members.

$$da = \frac{s_3 - s_2}{E} \cot B + \frac{s_3 - s_1}{E} \cot Y \quad (1)$$

$$dB = \frac{s_1 - s_3}{E} \cot Y + \frac{s_1 - s_2}{E} \cot a \quad (2)$$

$$dY = \frac{s_2 - s_1}{E} \cot a + \frac{s_2 - s_3}{E} \cot B \quad (3)$$

The deflection angles of a beam subjected to given moments applied at the two ends.

$$M_1 = \frac{2EI}{l} (2T_1 + T_2) \quad (4)$$

$$M_2 = \frac{2EI}{l} (2T_2 + T_1) \quad (5)$$

Values of the deflection angles T in terms of the changes of angle da, etc.

$$T_{nm} = T_{nl} + \sum_1^n da \quad (6)$$

The moments at any joint in terms of the deflection angles T.

(See formula 17, page 432- Johnson, Bryan, Turneaure,- Part 11.) \quad (7)



The moment and fibre stress in terms of T.

$$M_{nm} = 2 EK_{nm} (2T_{nm} + T_{mn}) \quad (8)$$

$$f_{nm} = \frac{2Ec}{l} (2T_{nm} + T_{mn}) \quad (9)$$

In these equations M_{nm} and f_{nm} are respectively the bending moments and fibre stress at joint n in member nm, and c = distance of fibre from neutral axis.



Explanation of Tables.

Table A. Data necessary for the determination of constants.

Table B. Calculation of changes of angle, arranged by triangles.

Table C. Calculation of ΣdL and $K\Sigma dL$ at the several joints.

Table D. Formulation of equations using Table C.

Table E. Solution of equations.

Table F. Determination of fibre stress for each member at each joint.

Table G. Values of secondary stresses in terms of percentage of maximum primary stresses.



Bibliography.

Johnson, Bryan, and Turneaure. Part 2.

Grimm " Secondary Stresses in Bridge Trusses ".

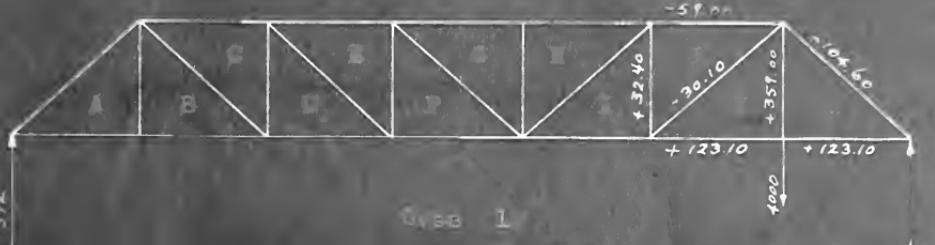
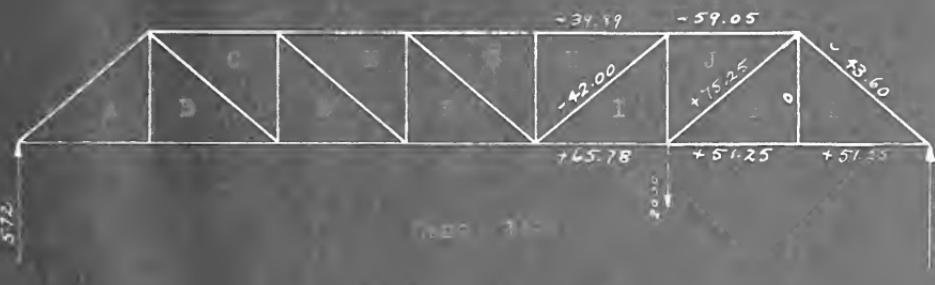
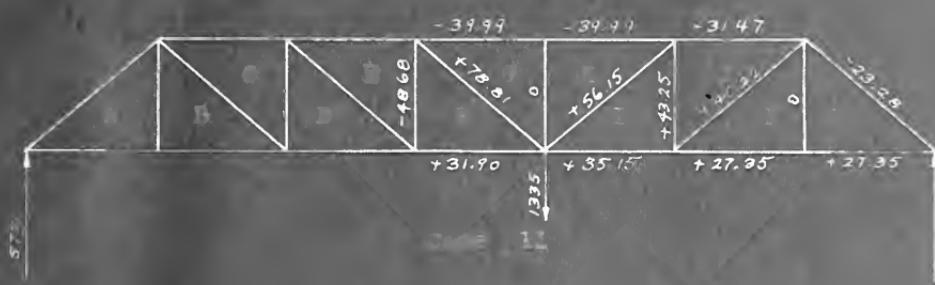
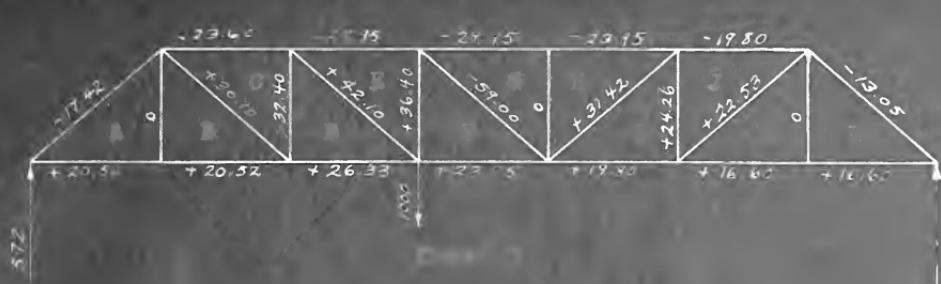
A.R.E.A. 1914, Volume 15 of Proceedings.

Waddell- Engineering News, 1914.

Engineering News, 1912.

Turneaure- Engineering News, 1912.

F.C.Kung- Engineering News, Volume 66, page 397.







Tri-Angle	Angle	Factor of cot a	(1.3333)	(.7500)	aL
A	1		0	17.42	14.65
	2	-17.42	-17.42	0	-63.71
	3	22.02	17.42		50.68
B	3	30.10	-20.52	30.10 - 0	35.39
	4	21.52	-30.10	0	-12.79
	5			-30.10	-21.60
C	3	-22.60	-30.10	-32.40 - 30.10	-46.83
	4	30.10	23.60	50.10 32.40	-71.60
	5				118.43
D	4	42.10	-26.33	4 - 10 32.40	76.90
	5	26.33	-42.10		-21.05
	6			-32.40 - 42.10	-55.85
E	5	-22.35	-42.10	36.40 - 42.10	-5.70
	6	42.10	29.95	42.10 - 36.40	-96.00
	7				101.70
F	6	-59.00	-20.95	-59.00 - 36.40	-178.30
	7	23.95	59.00		82.95
	8			36.40 59.00	95.40
G	7	-59.00	29.95	0 59.00	59.00
	8	29.95	59.00	-59.00 0	-88.05
	9				29.05
H	8	31.42	23.95	31.42 0	85.79
	9	-23.95	-31.42	0 - 31.42	-54.87
	10				-31.42
I	9	19.80	-31.42	24.26 - 31.42	-15.37
	10	31.42	-19.80	31.42 - 24.26	20.87
	11				
J	10	22.53	19.80	22.53 - 24.26	55.20
	11	-19.80	-23.53		-56.50
	12			24.26 - 22.53	1.30
K	11			0 - 22.53	-16.90
	12	16.60	-22.53		-17.91
	13	22.53	-16.60	22.53 0	24.81
L	12	16.60	15.05		39.56
	13	-13.05	-16.60	-16.05 0	-49.36
	14			0 13.05	9.80

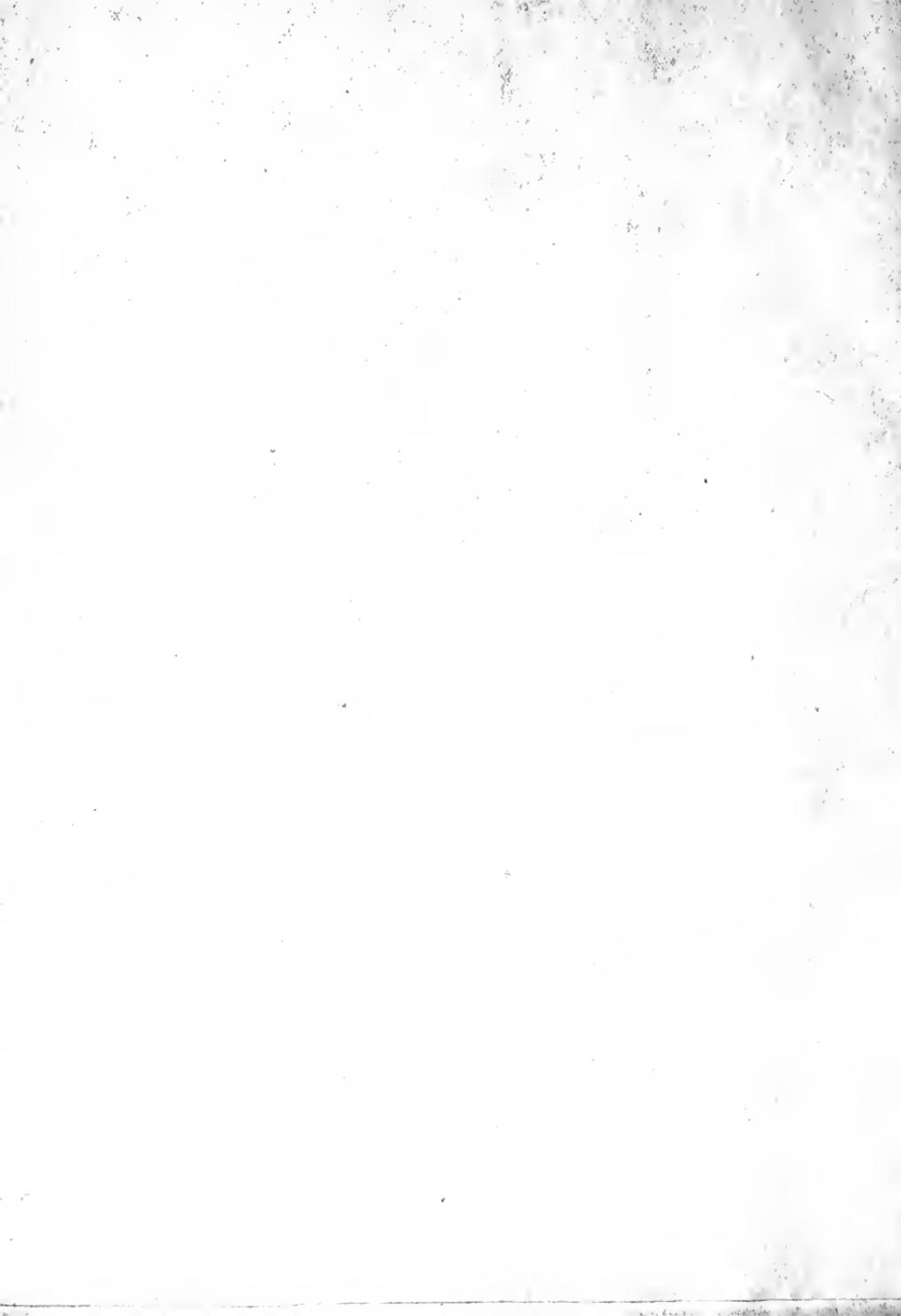
TABLE B-2

Tri-angle	Angle	Factor of cot e (1.3333)	Factor of cot g (1.3333)	d _e
E	5	-19.95 -99.10	-45.05 -10.10	118
	6	-46.10 -99.98	-42.10 -97.60	164 118
	7			
F	6	78.81 -31.90	78.81 48.68	168.25
	7	51.90 -78.81	-48.68 -78.81	-62.50
	9			-95.75
G	7			
	8	78.81 -31.99	78.81 -0	-58.15
	9	-39.99 -78.81		-158.40
H	8	56.15 39.99	56.15 -0	170.30
	9	-39.99 -56.15		-128.20
	10			-42.10
I	9	35.16 -56.15	43.25 -56.15	9.67
	10	56.15 -35.15	-	-28.00
	11			37.67
J	9	40.20 -01.47	40.22 -43.25	93.33
	10	-1.47 -10.22	-43.25 -40.22	-95.60
	11			2.27
K	9	37.65 -10.32	C -40.22	-30.16
	10	-40.18 -27.35	-40.22 -0	-17.16
	11			47.31
L	9	41.10 53.28	-	67.43
	10	-29.36 -29.36	-	-60.09
	11			17.46



1

Segment	Start	End	ΣdL	$\Sigma \delta L$
1	1-2	2-3	1000.00	1000.00
2	3-4	4-5	1000.00	1000.00
3	5-6	6-7	1000.00	1000.00
4	7-8	8-9	1000.00	1000.00
5	9-10	10-11	1000.00	1000.00
6	11-12	12-13	1000.00	1000.00
7	13-14	14-15	1000.00	1000.00
8	15-16	16-17	1000.00	1000.00



Calculation of \mathbf{IdL} and \mathbf{KdL}

Case 1

Joint	Member	K	\mathbf{F}_W	\mathbf{d}_L	\mathbf{IdL}	\mathbf{KdL}
1	1-2	1.00	1-1-2	13.0t	13.0t	200.5t
	1-3	1.00	1-1-3	1.0t	1.0t	202.5t
	1-4	1.00	1-1-4	1.0t	1.0t	200.5t
2	2-3	1.00	2-2-3	1.0t	1.0t	100.5t
	2-4	1.00	2-2-4	1.0t	1.0t	100.5t
	2-1	1.00	2-2-1	1.0t	1.0t	100.5t
3	3-5	1.00	3-3-5	1.0t	1.0t	50
	3-2	1.00	3-3-2	1.0t	1.0t	50
	3-1	1.00	3-3-1	1.0t	1.0t	50
4	4-5	1.00	4-4-5	1.0t	1.0t	50
	4-2	1.00	4-4-2	1.0t	1.0t	50
	4-1	1.00	4-4-1	1.0t	1.0t	50
5	5-7	1.00	5-5-7	1.0t	1.0t	50
	5-6	1.00	5-5-6	1.0t	1.0t	50
	5-3	1.00	5-5-3	1.0t	1.0t	50
6	6-8	1.00	6-6-8	1.0t	1.0t	50
	6-5	1.00	6-6-5	1.0t	1.0t	50
	6-3	1.00	6-6-3	1.0t	1.0t	50
7	7-8	1.00	7-7-8	1.0t	1.0t	50
	7-5	1.00	7-7-5	1.0t	1.0t	50
	7-3	1.00	7-7-3	1.0t	1.0t	50
8	8-9	1.00	8-8-9	1.0t	1.0t	50
	8-7	1.00	8-8-7	1.0t	1.0t	50
	8-5	1.00	8-8-5	1.0t	1.0t	50
9	9-10	1.00	9-9-10	1.0t	1.0t	50
	9-8	1.00	9-9-8	1.0t	1.0t	50
	9-6	1.00	9-9-6	1.0t	1.0t	50
10	10-12	1.00	10-10-12	1.0t	1.0t	50
	10-5	1.00	10-10-5	1.0t	1.0t	50
	10-3	1.00	10-10-3	1.0t	1.0t	50
11	11-13	1.00	11-11-13	1.0t	1.0t	50
	11-12	1.00	11-11-12	1.0t	1.0t	50
	11-14	1.00	11-11-14	1.0t	1.0t	50
12	12-14	1.00	12-12-14	1.0t	1.0t	50
	12-13	1.00	12-12-13	1.0t	1.0t	50
	12-5	1.00	12-12-5	1.0t	1.0t	50
13	13-11	1.00	13-13-11	1.0t	1.0t	50
	13-12	1.00	13-13-12	1.0t	1.0t	50
	13-14	1.00	13-13-14	1.0t	1.0t	50
14	14-11	1.00	14-14-11	1.0t	1.0t	50
	14-12	1.00	14-14-12	1.0t	1.0t	50
	14-13	1.00	14-14-13	1.0t	1.0t	50

136.70



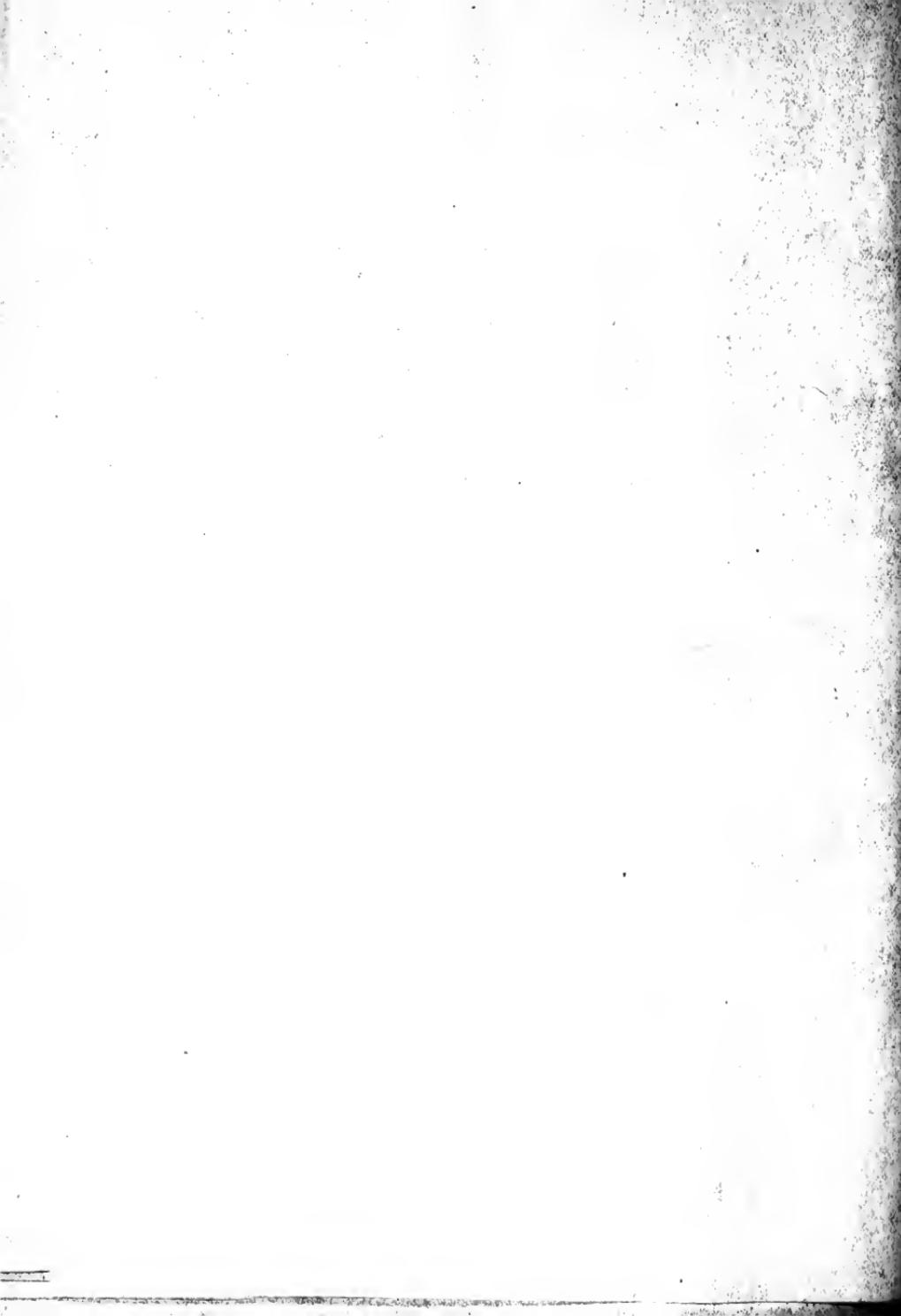


TABLE C-2

Construction of Σ_{III} and Σ_{II}

Case 11

Joint	Number	r_i	$\sin \theta_i$	ϕ_i	θ_{ED}	θ_{ED}	KedL
5	5-7	23.30	-	-	-	65.10	167.20
	5-8	35.14	-	-	-	80.23	139.40
	5-9	35.14	-	-	-	45.03	71.40
	5-10	35.14	-	-	-	31.40	31.40
6	6-4	40.54	-	-	-	51.65	116.00
	6-5	15.95	-	-	-	30.35	116.00
	6-7	15.95	-	-	-	30.35	116.00
	6-10	15.95	-	-	-	30.35	116.00
7	7-5	30.00	-	-	-	71.30	116.00
	7-6	30.00	-	-	-	71.30	116.00
	7-7	30.00	-	-	-	71.30	116.00
	7-10	30.00	-	-	-	71.30	116.00
8	8-6	50.00	-	-	-	71.30	116.00
	8-7	15.00	-	-	-	30.35	116.00
	8-9	15.00	-	-	-	30.35	116.00
	8-10	15.00	-	-	-	30.35	116.00
9	9-7	47.42	-	-	-	71.30	116.00
	9-8	47.42	-	-	-	71.30	116.00
	9-10	47.42	-	-	-	71.30	116.00
	9-11	47.42	-	-	-	71.30	116.00
10	10-11	47.42	-	-	-	71.30	116.00
	10-12	47.42	-	-	-	71.30	116.00
	10-13	47.42	-	-	-	71.30	116.00
	10-14	47.42	-	-	-	71.30	116.00
11	11-9	47.42	-	-	-	71.30	116.00
	11-10	47.42	-	-	-	71.30	116.00
	11-12	47.42	-	-	-	71.30	116.00
	11-13	47.42	-	-	-	71.30	116.00
12	12-14	40.71	-	-	-	57.32	187.26
	12-15	40.71	-	-	-	50.29	239.80
	12-16	40.71	-	-	-	51.45	1152.80
	12-17	40.71	-	-	-	50.29	1152.80
13	13-11	45.95	-	-	-	71.30	116.00
	13-12	45.95	-	-	-	71.30	116.00
	13-14	45.95	-	-	-	71.30	116.00
	13-15	45.95	-	-	-	71.30	116.00
14	14-13	15.85	-	-	-	30.35	45.00
	14-14	15.85	-	-	-	30.35	45.00
	14-15	15.85	-	-	-	30.35	45.00
	14-16	15.85	-	-	-	30.35	45.00



Calculation of ΣdL and $K\Sigma dL$

Table III

tot. t	denom.	K	$\Delta \Sigma L$	ΣL	ΣdL
3	6-10 6-7	0.0 1.00 0.00 <hr/> 4.9 x 4.0	-10.00 -7 <hr/> -7	-10.00 -7 <hr/> -7	-10.00 -7 <hr/> -7
3	6-7 6-5 6-1 6-2 <hr/> 4.9 x 4.0	1.70 1.5 1.7 1.4 <hr/> 4.9	-7 -7 -10 -11 <hr/> -11	-7 -7 -10 -11 <hr/> -11	-7 -7 -10 -11 <hr/> -11
				0.0	0.0



TABLE C-3

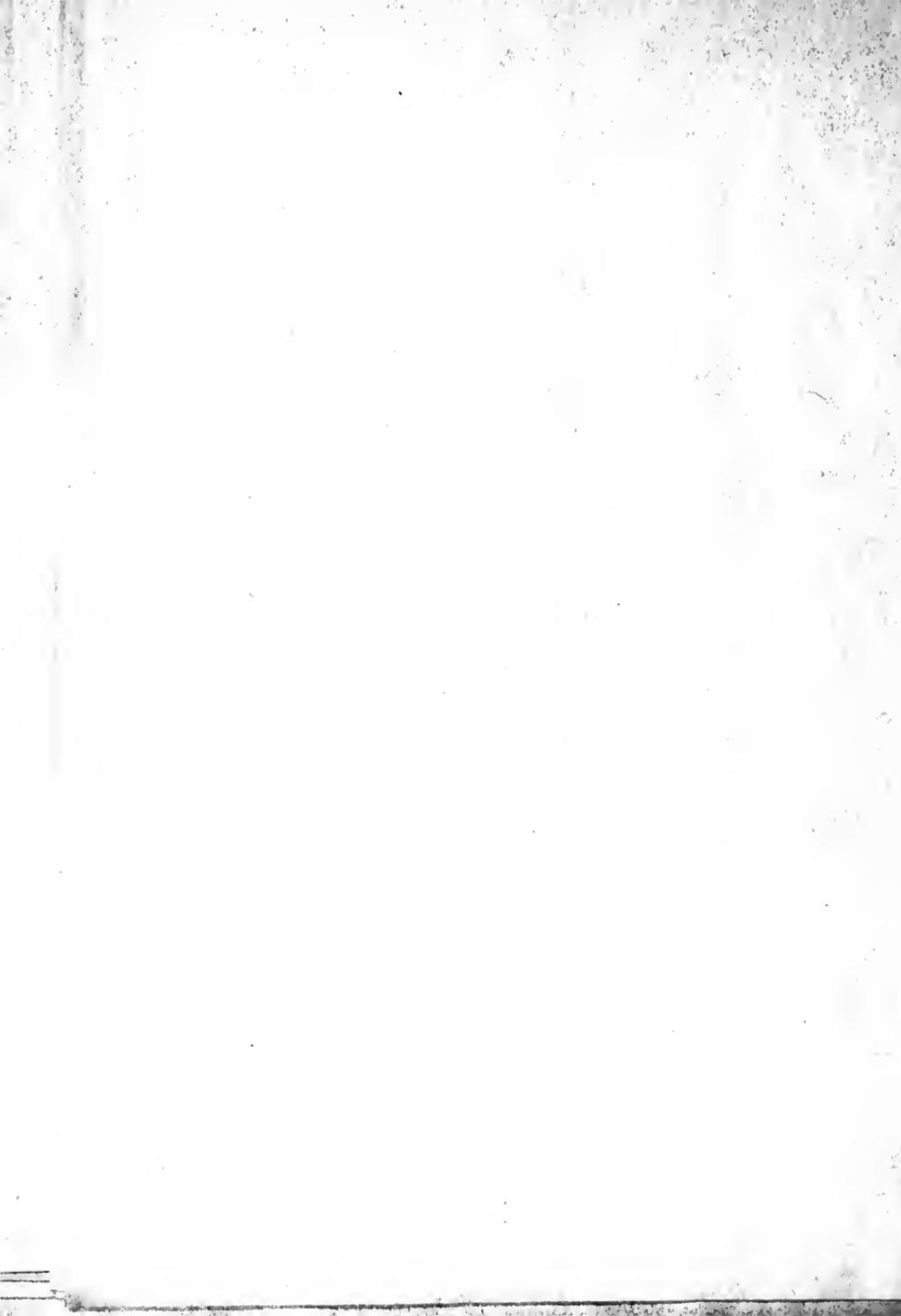
Calculation of SdL and RsdL

Case 111

Joint	Member	K	Angle	dL	LdL	RsdL
S	0-10	25.40	-----	-----	-----	-----
	0-9	1.09	10-6-9	-34.10	-34.10	-7.28
	0-7	25.40	9-1-7	+17.59	185.47	(221.20)
	47-40	47.40				47.077
7	7-6	1.70	6-7	-----	-----	-----
	7-7	1.70	6-7	-36.75	-36.75	0
	7-9	1.09	7-3-6	-15.98	-25.45	-7.00
	7-10	1.71	7-3-6	-15.98	-25.147	-1.00
8	8-10	1.71	7-3-6	-15.98	-25.147	-1.00
	8-11	1.71	10-4-11	-1.11	-15.98	-0.00
	47-56	47.56				
	10-11	1.71				0.0
10	10-11	1.71	2-3-11	-----	-----	-----
	10-9	1.71	2-3-11	-1.11	1.11	0.0
	10-6	1.71	2-3-11	-1.11	1.11	0.0
	47-56	47.56				
11	1-10	1.71	1-1-10	-----	-----	-----
	1-4	1.71	1-1-10	-1.11	-1.11	0.0
	1-3	0.77	1-1-10	-1.11	-1.11	0.0
	1-2	23.43	1-1-10	-1.11	-1.11	0.0
12	1-10	1.71	2-3-12	-----	-----	-----
	1-2	1.71	2-3-12	-1.11	-1.11	0.0
	1-1	1.71	2-3-12	-1.11	-1.11	0.0
	47-56	47.56				
13	1-10	1.71	2-3-13	-----	-----	-----
	1-2	1.71	2-3-13	-1.11	-1.11	0.0
	1-1	1.71	2-3-13	-1.11	-1.11	0.0
	47-56	47.56				
14	1-10	1.71	2-3-14	-----	-----	-----
	1-2	1.71	2-3-14	-1.11	-1.11	0.0
	1-1	1.71	2-3-14	-1.11	-1.11	0.0
	47-56	47.56				

Tabulation of Equations

Equation No.	Left member of Equation	Absolute Terms		
		Case 1	Case 11	Case 111
1	$65.8871 + 15.3570 \cdot t + 15.2653$		280.10	
2	$15.6671 + 17.7070 \cdot t + 17.53 + 16.4074$		- 1187.26	
3	$1.9917 + 2.7070 \cdot t + 7.42 \cdot t^2 + 4.77 \cdot t^3 + 3.88 \cdot t^4$		187.35	
4	$1.6667 + 2.7 + 11.30 \cdot t + 8.047 \cdot t^2 + 1.6 \cdot t^3$		- 2049.55	
5	$2.5 + 1.6667 + 16.1 \cdot t + 6.73 \cdot t^2 + 3.5 \cdot t^3 + 0.7$		- 9235.44	- 1258.00
6	$3.0 + 2.7 + 11.30 \cdot t + 8.047 \cdot t^2 + 3.0 \cdot t^3 + 1.7679$		13824.03	1620.12
7	$2.0 + 0^m + 1.000 + 2.0 \cdot 5.017 + 2.0 \cdot 2.078 + 1.7379$		- 11780.65	7533.99



Solution of Equations

			Ab. elucte terms			
			Case I	Case II	Case III	Case IV
C	$\frac{1}{2}$	$\frac{1}{2}$	360.10			
C	0	0	1137.65			
1	$\frac{1}{2}$	$\frac{1}{2}$	167.35			
2	$\frac{1}{2}$	$\frac{1}{2}$	-2057.65			
3	$\frac{1}{2}$	$\frac{1}{2}$	$-9.5E-44$			
4	$\frac{1}{2}$	$\frac{1}{2}$	1520.09	1620.12	1620.12	1620.12
5	$\frac{1}{2}$	$\frac{1}{2}$	$-9.5E-44$	-1352.30		
6	$\frac{1}{2}$	$\frac{1}{2}$	1520.09	1620.12	1620.12	1620.12
7	$\frac{1}{2}$	$\frac{1}{2}$	-117.65	7635.99		
8	$\frac{1}{2}$	$\frac{1}{2}$	-62.0	1660.10	-17120.5	$+120.0$
9	$\frac{1}{2}$	$\frac{1}{2}$	-71.00	-27.70	$+120.0$	
10	$\frac{1}{2}$	$\frac{1}{2}$	-60.0	-6370.4	-211.0	$+13769.$
11	$\frac{1}{2}$	$\frac{1}{2}$	-1	$+1.0$	-53.14	$20E35.4$
12	$\frac{1}{2}$	$\frac{1}{2}$	-1050.50	-17.00	-21.0	$-33335.$
13	$\frac{1}{2}$	$\frac{1}{2}$	1	$+1.0$	-120.0	$31.570.$
14	$\frac{1}{2}$	$\frac{1}{2}$	-10.10	-1.0	1.0	0.01



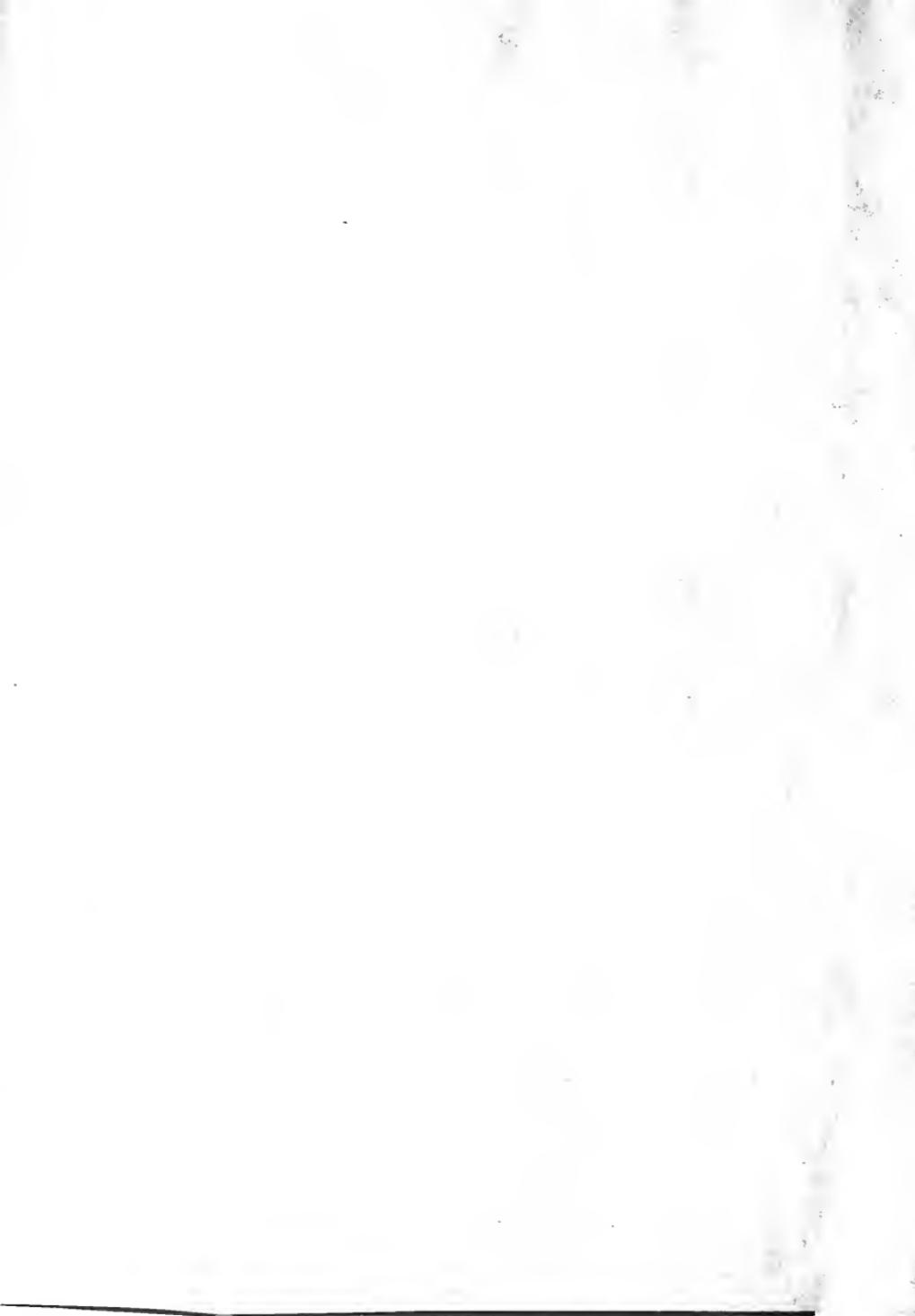
Salinity and dynamics

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Note change in column headings

TABLE E (cont.)

Notes on column readings



Case 1 1000 # of points 6

Joint	Assembly	Case 1		1000° F at point 6	
		T	2T _{IN}	T _{IN} + T _{OUT}	f
1	1-3	-0.20	5.05	5.71	0.40
	1-3	-0.12	5.03	5.71	0.45
	1-3	-0.08	5.12	5.71	0.60
	2-1	-0.08	-0.74	5.44	1.00
	2-1	-0.04	-0.74	5.44	1.00
	2-1	-0.02	-0.74	5.44	1.00
11	11-9	-0.06	24.05	101.51	13.02
	11-10	-0.02	24.05	111.02	19.36
	11-10	-0.02	23.96	111.45	19.36
	11-10	-0.02	23.96	111.47	19.36
	11-10	-0.02	23.96	111.47	19.36
	11-10	-0.02	23.96	111.47	19.36
12	12-14	-0.06	-0.62	-5.45	2.14
	12-14	-0.07	-0.62	-5.45	2.34
	12-14	-0.10	-0.62	-5.45	2.43
	12-14	-0.08	-0.62	-5.45	2.47
	12-14	-0.06	-0.62	-5.45	2.47
13	13-17	-0.04	-0.19	0.1	0.2
	13-16	-0.05	-0.19	0.1	0.16
	13-16	-0.06	-0.19	0.1	0.16
	13-16	-0.08	-0.19	0.1	0.16
14	14-15	-0.05	-0.19	0.1	0.14
	14-15	-0.06	-0.19	0.1	0.14
	14-15	-0.08	-0.19	0.1	0.14
	14-15	-0.10	-0.19	0.1	0.14

E (cont.)

Note change in column headings

TABLE E (cont.)

Note on use in column headings

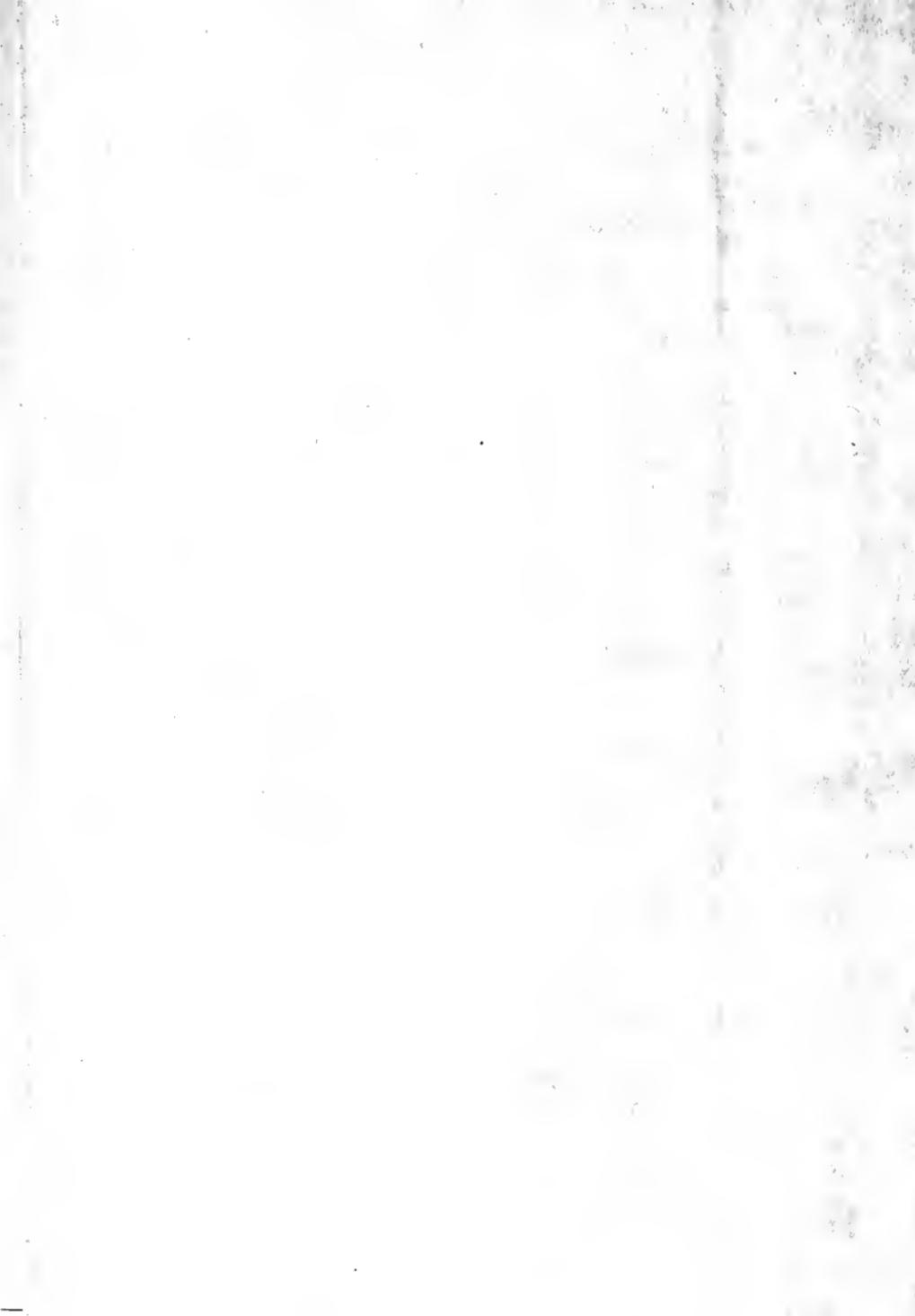
VOLUME CP T

Case 11 1000 # at point 9

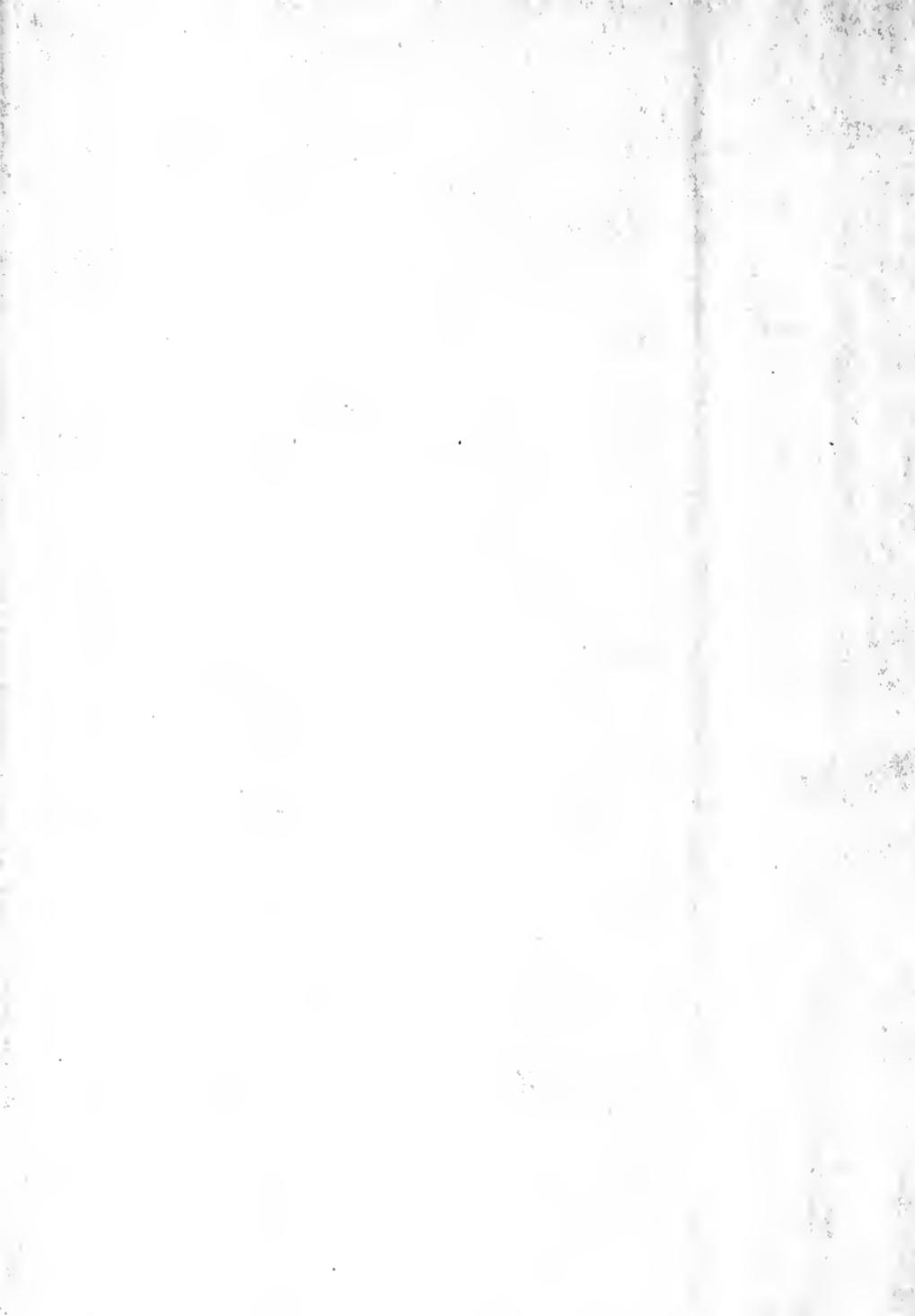
Joint	Location	C		T		2mm + 2mm		F	
		1	2	1	2	1	2	1	2
1	1-1	-0.02	-0.02	-0.02	-0.02	-0.15	-0.15	0.15	0.15
	1-2	-0.08	-0.08	-0.06	-0.06	-0.25	-0.25	0.75	0.75
	1-3	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	2-1	-0.08	-0.08	-0.06	-0.06	-0.25	-0.25	0.75	0.75
2	1-1	-0.02	-0.02	-0.02	-0.02	-0.15	-0.15	0.15	0.15
	1-2	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-3	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-4	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-5	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-6	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-7	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-8	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-9	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-10	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
3	1-11	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-12	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-13	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-14	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
4	1-15	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-16	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-17	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75
	1-18	-0.08	-0.08	-0.08	-0.08	-0.25	-0.25	0.75	0.75



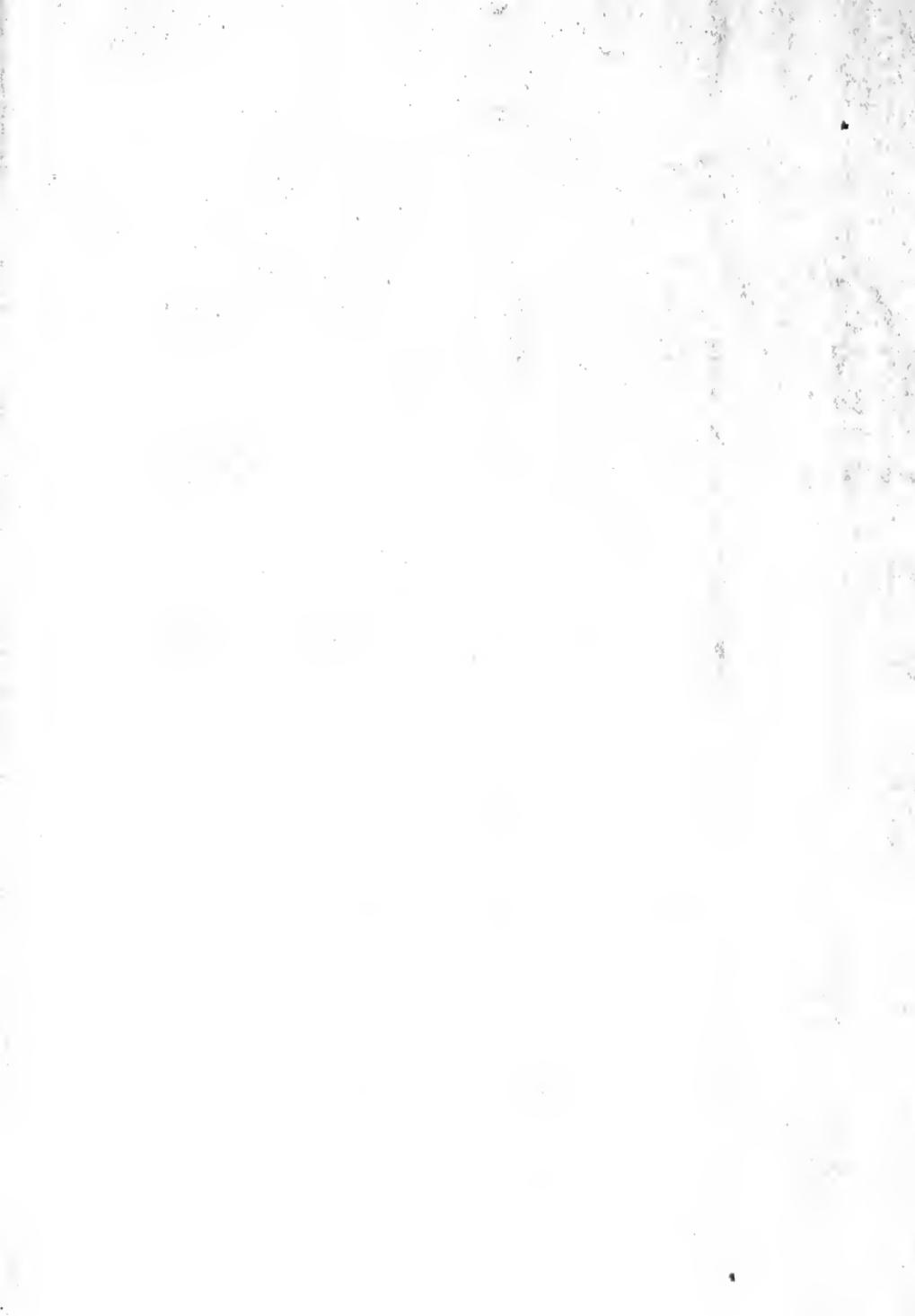
Joint	Number	$\frac{a}{l}$	Case 11			1000 # at point 9	f
			T	CT run + Tmm	CT run		
1	1-2	.039	6.92	8.96	8.96	0.58	
	1-3	.040	5.06	7.05	7.05	0.72	
	1-4	.058	21.00	27.30	27.30	2.56	
2	-1	.058	-1.76	-1.54	-1.54	-1.00	
	-2	.07	-3.7	-3.16	-3.16	-1.48	
	-3	.052	-4.50	-7.05	-7.05	-6.00	
3	-4	.04	1.06	1.10	1.10	1.4	
	-5	.058	1.06	1.10	1.10	1.32	
	-6	.050	-.75	1.70	1.70	1.50	
4	-7	.07	55.54	1.00	1.00	24.00	
	-8	.033	7.30	7.00	7.00	6.00	
	-9	.042	7.09	6.50	6.50	6.10	
5	-10	.051	-1.70	-7.00	-7.00	-1.10	
	-11	.028	-6.49	-11.73	-11.73	-1.92	
	-12	.042	-1.712	-21.75	-21.75	-20.10	
6	-13	.052	-6.45	-7.1	-7.1	.60	
	-14	.052	-1.75	-1.75	-1.75	-1.00	
	-15	.052	-1.75	-1.75	-1.75	-1.00	
7	-16	.052	-1.75	-1.75	-1.75	-1.00	
	-17	.052	-1.75	-1.75	-1.75	-1.00	
	-18	.052	-1.75	-1.75	-1.75	-1.00	
8	-19	.054	-1.02	-27.1	-27.1	-1.10	
	-20	.054	-1.02	-27.1	-27.1	-1.10	
	-21	.054	-1.02	-27.1	-27.1	-1.10	
9	-22	.052	-1.75	-1.75	-1.75	-1.00	
	-23	.052	-1.75	-1.75	-1.75	-1.00	
	-24	.052	-1.75	-1.75	-1.75	-1.00	
10	-25	.052	-1.75	-1.75	-1.75	-1.00	
	-26	.052	-1.75	-1.75	-1.75	-1.00	
	-27	.052	-1.75	-1.75	-1.75	-1.00	
11	-28	.052	-1.75	-1.75	-1.75	-1.00	
	-29	.052	-1.75	-1.75	-1.75	-1.00	
	-30	.052	-1.75	-1.75	-1.75	-1.00	
12	-31	.052	-1.75	-1.75	-1.75	-1.00	
	-32	.052	-1.75	-1.75	-1.75	-1.00	
	-33	.052	-1.75	-1.75	-1.75	-1.00	
13	-34	.052	-1.75	-1.75	-1.75	-1.00	
	-35	.052	-1.75	-1.75	-1.75	-1.00	
	-36	.052	-1.75	-1.75	-1.75	-1.00	
14	-37	.052	-1.75	-1.75	-1.75	-1.00	
	-38	.052	-1.75	-1.75	-1.75	-1.00	
	-39	.052	-1.75	-1.75	-1.75	-1.00	
15	-40	.052	-1.75	-1.75	-1.75	-1.00	
	-41	.052	-1.75	-1.75	-1.75	-1.00	
	-42	.052	-1.75	-1.75	-1.75	-1.00	
16	-43	.052	-1.75	-1.75	-1.75	-1.00	
	-44	.052	-1.75	-1.75	-1.75	-1.00	
	-45	.052	-1.75	-1.75	-1.75	-1.00	
17	-46	.052	-1.75	-1.75	-1.75	-1.00	
	-47	.052	-1.75	-1.75	-1.75	-1.00	
	-48	.052	-1.75	-1.75	-1.75	-1.00	
18	-49	.052	-1.75	-1.75	-1.75	-1.00	
	-50	.052	-1.75	-1.75	-1.75	-1.00	
	-51	.052	-1.75	-1.75	-1.75	-1.00	
19	-52	.052	-1.75	-1.75	-1.75	-1.00	
	-53	.052	-1.75	-1.75	-1.75	-1.00	
	-54	.052	-1.75	-1.75	-1.75	-1.00	
20	-55	.052	-1.75	-1.75	-1.75	-1.00	
	-56	.052	-1.75	-1.75	-1.75	-1.00	
	-57	.052	-1.75	-1.75	-1.75	-1.00	
21	-58	.052	-1.75	-1.75	-1.75	-1.00	
	-59	.052	-1.75	-1.75	-1.75	-1.00	
	-60	.052	-1.75	-1.75	-1.75	-1.00	
22	-61	.052	-1.75	-1.75	-1.75	-1.00	
	-62	.052	-1.75	-1.75	-1.75	-1.00	
	-63	.052	-1.75	-1.75	-1.75	-1.00	
23	-64	.052	-1.75	-1.75	-1.75	-1.00	
	-65	.052	-1.75	-1.75	-1.75	-1.00	
	-66	.052	-1.75	-1.75	-1.75	-1.00	
24	-67	.052	-1.75	-1.75	-1.75	-1.00	
	-68	.052	-1.75	-1.75	-1.75	-1.00	
	-69	.052	-1.75	-1.75	-1.75	-1.00	
25	-70	.052	-1.75	-1.75	-1.75	-1.00	
	-71	.052	-1.75	-1.75	-1.75	-1.00	
	-72	.052	-1.75	-1.75	-1.75	-1.00	
26	-73	.052	-1.75	-1.75	-1.75	-1.00	
	-74	.052	-1.75	-1.75	-1.75	-1.00	
	-75	.052	-1.75	-1.75	-1.75	-1.00	
27	-76	.052	-1.75	-1.75	-1.75	-1.00	
	-77	.052	-1.75	-1.75	-1.75	-1.00	
	-78	.052	-1.75	-1.75	-1.75	-1.00	
28	-79	.052	-1.75	-1.75	-1.75	-1.00	
	-80	.052	-1.75	-1.75	-1.75	-1.00	
	-81	.052	-1.75	-1.75	-1.75	-1.00	
29	-82	.052	-1.75	-1.75	-1.75	-1.00	
	-83	.052	-1.75	-1.75	-1.75	-1.00	
	-84	.052	-1.75	-1.75	-1.75	-1.00	
30	-85	.052	-1.75	-1.75	-1.75	-1.00	
	-86	.052	-1.75	-1.75	-1.75	-1.00	
	-87	.052	-1.75	-1.75	-1.75	-1.00	
31	-88	.052	-1.75	-1.75	-1.75	-1.00	
	-89	.052	-1.75	-1.75	-1.75	-1.00	
	-90	.052	-1.75	-1.75	-1.75	-1.00	
32	-91	.052	-1.75	-1.75	-1.75	-1.00	
	-92	.052	-1.75	-1.75	-1.75	-1.00	
	-93	.052	-1.75	-1.75	-1.75	-1.00	
33	-94	.052	-1.75	-1.75	-1.75	-1.00	
	-95	.052	-1.75	-1.75	-1.75	-1.00	
	-96	.052	-1.75	-1.75	-1.75	-1.00	
34	-97	.052	-1.75	-1.75	-1.75	-1.00	
	-98	.052	-1.75	-1.75	-1.75	-1.00	
	-99	.052	-1.75	-1.75	-1.75	-1.00	
35	-100	.052	-1.75	-1.75	-1.75	-1.00	
	-101	.052	-1.75	-1.75	-1.75	-1.00	
	-102	.052	-1.75	-1.75	-1.75	-1.00	
36	-103	.052	-1.75	-1.75	-1.75	-1.00	
	-104	.052	-1.75	-1.75	-1.75	-1.00	
	-105	.052	-1.75	-1.75	-1.75	-1.00	
37	-106	.052	-1.75	-1.75	-1.75	-1.00	
	-107	.052	-1.75	-1.75	-1.75	-1.00	
	-108	.052	-1.75	-1.75	-1.75	-1.00	
38	-109	.052	-1.75	-1.75	-1.75	-1.00	
	-110	.052	-1.75	-1.75	-1.75	-1.00	
	-111	.052	-1.75	-1.75	-1.75	-1.00	
39	-112	.052	-1.75	-1.75	-1.75	-1.00	
	-113	.052	-1.75	-1.75	-1.75	-1.00	
	-114	.052	-1.75	-1.75	-1.75	-1.00	
40	-115	.052	-1.75	-1.75	-1.75	-1.00	
	-116	.052	-1.75	-1.75	-1.75	-1.00	
	-117	.052	-1.75	-1.75	-1.75	-1.00	
41	-118	.052	-1.75	-1.75	-1.75	-1.00	
	-119	.052	-1.75	-1.75	-1.75	-1.00	
	-120	.052	-1.75	-1.75	-1.75	-1.00	
42	-121	.052	-1.75	-1.75	-1.75	-1.00	
	-122	.052	-1.75	-1.75	-1.75	-1.00	
	-123	.052	-1.75	-1.75	-1.75	-1.00	
43	-124	.052	-1.75	-1.75	-1.75	-1.00	
	-125	.052	-1.75	-1.75	-1.75	-1.00	
	-126	.052	-1.75	-1.75	-1.75	-1.00	
44	-127	.052	-1.75	-1.75	-1.75	-1.00	
	-128	.052	-1.75	-1.75	-1.75	-1.00	
	-129	.052	-1.75	-1.75	-1.75	-1.00	
45	-130	.052	-1.75	-1.75	-1.75	-1.00	
	-131	.052	-1.75	-1.75	-1.75	-1.00	
	-132	.052	-1.75	-1.75	-1.75	-1.00	
46	-133	.052	-1.75	-1.75	-1.75	-1.00	
	-134	.052	-1.75	-1.75	-1.75	-1.00	
	-135	.052	-1.75	-1.75	-1.75	-1.00	
47	-136	.052	-1.75	-1.75	-1.75	-1.00	
	-137	.052	-1.75	-1.75	-1.75	-1.00	
	-138	.052	-1.75	-1.75	-1.75	-1.00	
48	-139	.052	-1.75	-1.75	-1.75	-1.00	
	-140	.052	-1.75	-1.75	-1.75	-1.00	
	-141	.052	-1.75	-1.75	-1.75	-1.00	
49	-142	.052	-1.75	-1.75	-1.75	-1.00	
	-143	.052	-1.75	-1.75	-1.75	-1.00	
	-144	.052	-1.75	-1.75	-1.75	-1.00	
50	-145	.052	-1.75	-1.75	-1.75	-1.00	
	-146	.052	-1.75	-1.75	-1.75	-1.00	
	-147	.052	-1.75	-1.75	-1.75	-1.00	
51	-148	.052	-1.75	-1.75	-1.75	-1.00	
	-149	.052	-1.75	-1.75	-1.75	-1.00	
	-150	.052	-1.75	-1.75	-1.75	-1.00	
52	-151	.052	-1.75	-1.75	-1.75	-1.00	
	-152	.052	-1.75	-1.75	-1.75	-1.00	
	-153	.052	-1.75	-1.75	-1.75	-1.00	
53	-154	.052	-1.75	-1.75	-1.75	-1.00	
	-155	.052	-1.75	-1.75	-1.75	-1.00	
	-156	.052	-1.75	-1.75	-1.75	-1.00	
54	-157	.052	-1.75	-1.75	-1.75	-1.00	
	-158	.052	-1.75	-1.75	-1.75	-1.00	
	-159	.052	-1.75	-1.75	-1.75	-1.00	
55	-160	.052	-1.75	-1.75	-1.75	-1.00	
	-161	.052	-1.75	-1.75	-1.75	-1.00	
	-162	.052	-1.75	-1.75	-1.75	-1.00	
56	-163	.052	-1.75	-1.75	-1.75	-1.00	
	-164	.052	-1.75	-1.75	-1.75	-1.00	
	-165	.052	-1.75	-1.75	-1.75	-1.00	
57	-166	.052	-1.75	-1.7			



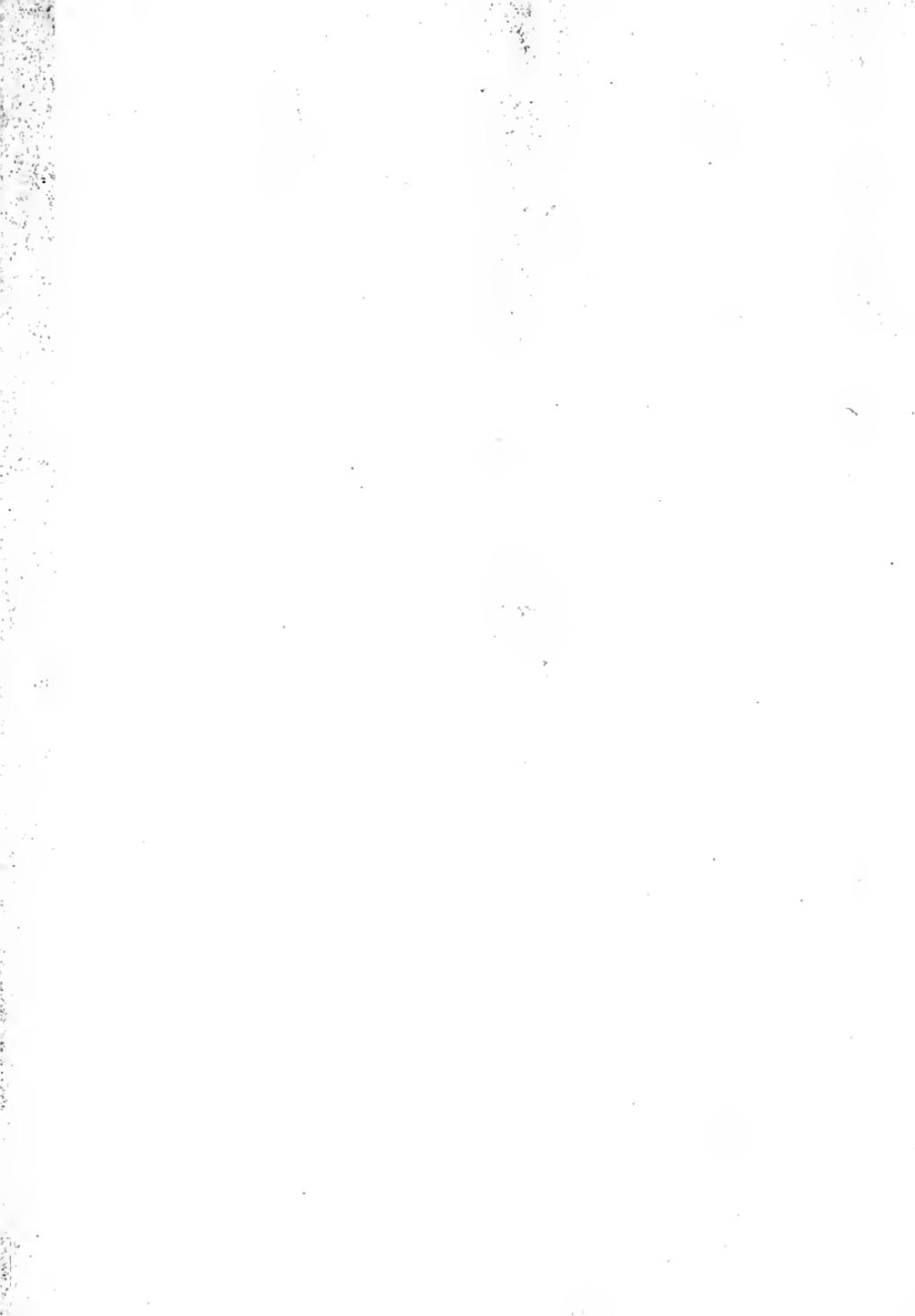
Joint	Number	Case III - 1000# at point 11			
		T	2T mm	T mm	f
1	1-4	0.02	0.15	0.58	0.37
	1-5	0.08	0.20	0.54	0.46
	1-2	0.08	0.17	0.54	1.60
	1-1	0.07	0.16	0.54	5.12
	1-6	0.07	0.16	0.54	5.12
	1-7	0.07	0.16	0.54	5.12
	1-8	0.07	0.16	0.54	5.12
	1-9	0.07	0.16	0.54	5.12
	1-10	0.07	0.16	0.54	5.12
	1-11	0.07	0.16	0.54	5.12
	1-12	0.07	0.16	0.54	5.12
	1-13	0.07	0.16	0.54	5.12
	1-14	0.07	0.16	0.54	5.12
	1-15	0.07	0.16	0.54	5.12
	1-16	0.07	0.16	0.54	5.12
	1-17	0.07	0.16	0.54	5.12
	1-18	0.07	0.16	0.54	5.12
	1-19	0.07	0.16	0.54	5.12
	1-20	0.07	0.16	0.54	5.12
	1-21	0.07	0.16	0.54	5.12
	1-22	0.07	0.16	0.54	5.12
	1-23	0.07	0.16	0.54	5.12
	1-24	0.07	0.16	0.54	5.12
	1-25	0.07	0.16	0.54	5.12
	1-26	0.07	0.16	0.54	5.12
	1-27	0.07	0.16	0.54	5.12
	1-28	0.07	0.16	0.54	5.12
	1-29	0.07	0.16	0.54	5.12
	1-30	0.07	0.16	0.54	5.12
	1-31	0.07	0.16	0.54	5.12
	1-32	0.07	0.16	0.54	5.12
	1-33	0.07	0.16	0.54	5.12
	1-34	0.07	0.16	0.54	5.12
	1-35	0.07	0.16	0.54	5.12
	1-36	0.07	0.16	0.54	5.12
	1-37	0.07	0.16	0.54	5.12
	1-38	0.07	0.16	0.54	5.12
	1-39	0.07	0.16	0.54	5.12
	1-40	0.07	0.16	0.54	5.12



Year	Period	Type	Actual		Budget		Variance	
			Actual	Budget	Budget	Variance	Variance	%
2000	Jan	Revenue	1000	1000	1000	0	0	0
2000	Feb	Revenue	1000	1000	1000	0	0	0
2000	Mar	Revenue	1000	1000	1000	0	0	0
2000	Apr	Revenue	1000	1000	1000	0	0	0
2000	May	Revenue	1000	1000	1000	0	0	0
2000	Jun	Revenue	1000	1000	1000	0	0	0
2000	Jul	Revenue	1000	1000	1000	0	0	0
2000	Aug	Revenue	1000	1000	1000	0	0	0
2000	Sep	Revenue	1000	1000	1000	0	0	0
2000	Oct	Revenue	1000	1000	1000	0	0	0
2000	Nov	Revenue	1000	1000	1000	0	0	0
2000	Dec	Revenue	1000	1000	1000	0	0	0
2000	Jan	Expenses	1000	1000	1000	0	0	0
2000	Feb	Expenses	1000	1000	1000	0	0	0
2000	Mar	Expenses	1000	1000	1000	0	0	0
2000	Apr	Expenses	1000	1000	1000	0	0	0
2000	May	Expenses	1000	1000	1000	0	0	0
2000	Jun	Expenses	1000	1000	1000	0	0	0
2000	Jul	Expenses	1000	1000	1000	0	0	0
2000	Aug	Expenses	1000	1000	1000	0	0	0
2000	Sep	Expenses	1000	1000	1000	0	0	0
2000	Oct	Expenses	1000	1000	1000	0	0	0
2000	Nov	Expenses	1000	1000	1000	0	0	0
2000	Dec	Expenses	1000	1000	1000	0	0	0
2001	Jan	Revenue	1000	1000	1000	0	0	0
2001	Feb	Revenue	1000	1000	1000	0	0	0
2001	Mar	Revenue	1000	1000	1000	0	0	0
2001	Apr	Revenue	1000	1000	1000	0	0	0
2001	May	Revenue	1000	1000	1000	0	0	0
2001	Jun	Revenue	1000	1000	1000	0	0	0
2001	Jul	Revenue	1000	1000	1000	0	0	0
2001	Aug	Revenue	1000	1000	1000	0	0	0
2001	Sep	Revenue	1000	1000	1000	0	0	0
2001	Oct	Revenue	1000	1000	1000	0	0	0
2001	Nov	Revenue	1000	1000	1000	0	0	0
2001	Dec	Revenue	1000	1000	1000	0	0	0
2001	Jan	Expenses	1000	1000	1000	0	0	0
2001	Feb	Expenses	1000	1000	1000	0	0	0
2001	Mar	Expenses	1000	1000	1000	0	0	0
2001	Apr	Expenses	1000	1000	1000	0	0	0
2001	May	Expenses	1000	1000	1000	0	0	0
2001	Jun	Expenses	1000	1000	1000	0	0	0
2001	Jul	Expenses	1000	1000	1000	0	0	0
2001	Aug	Expenses	1000	1000	1000	0	0	0
2001	Sep	Expenses	1000	1000	1000	0	0	0
2001	Oct	Expenses	1000	1000	1000	0	0	0
2001	Nov	Expenses	1000	1000	1000	0	0	0
2001	Dec	Expenses	1000	1000	1000	0	0	0

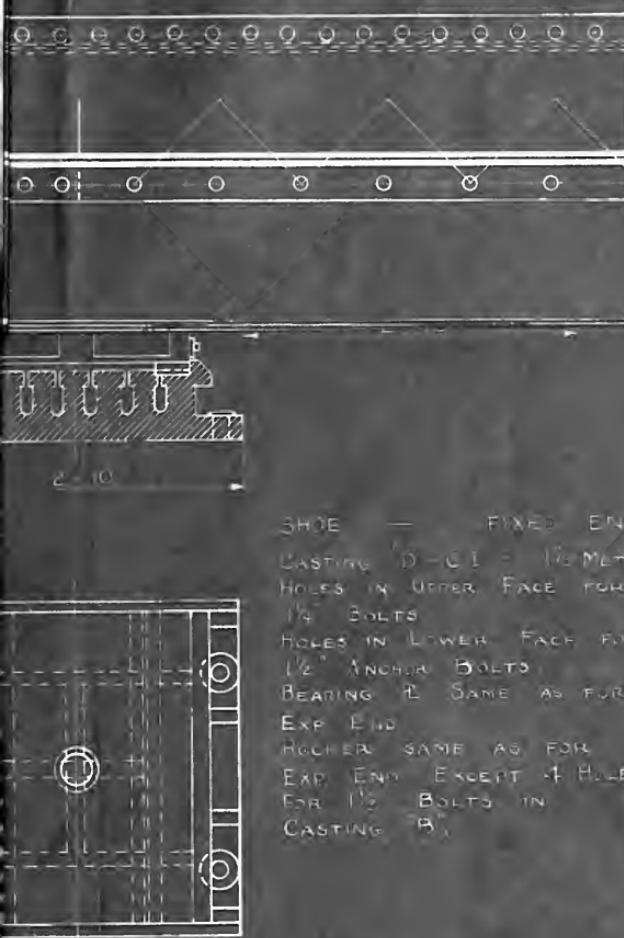




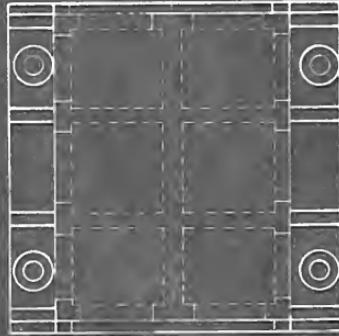


teous
CHNOL
ent
GN
cale
brush.





SHOE — FIXED END
 CASTING D-C-1 = 1½ METAL
 HOLES IN UPPER FACE FOR
 ¼" BOLTS
 HOLES IN LOWER FACE FOR
 ½" ANCHOR BOLTS
 BEARING IS SAME AS FOR
 EXP END
 ROCKER SAME AS FOR
 EXP END EXCEPT 4 HULBS
 FOR ½" BOLTS IN
 CASTING B



NY TRUSS

IONS
NG
s 1½" DIAM

HOLDS 9" DIAM

11/4/20
R. L. Stevens

ARMOUR INSTITUTE OF TECHNOLOGY
Civil Engineering Department

BRIDGE DESIGN

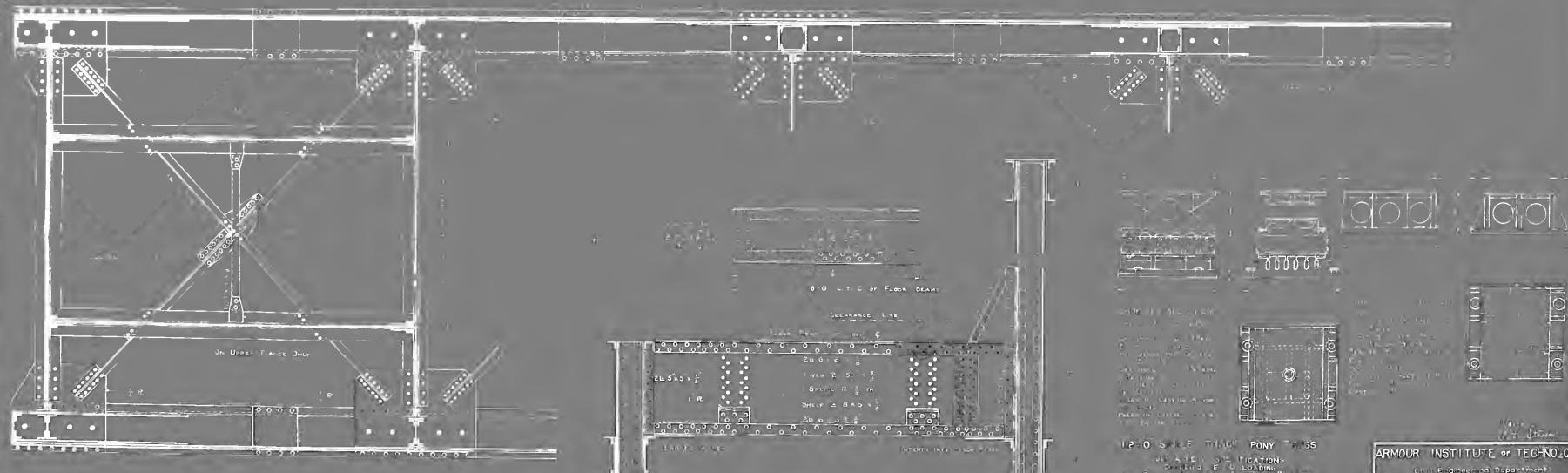
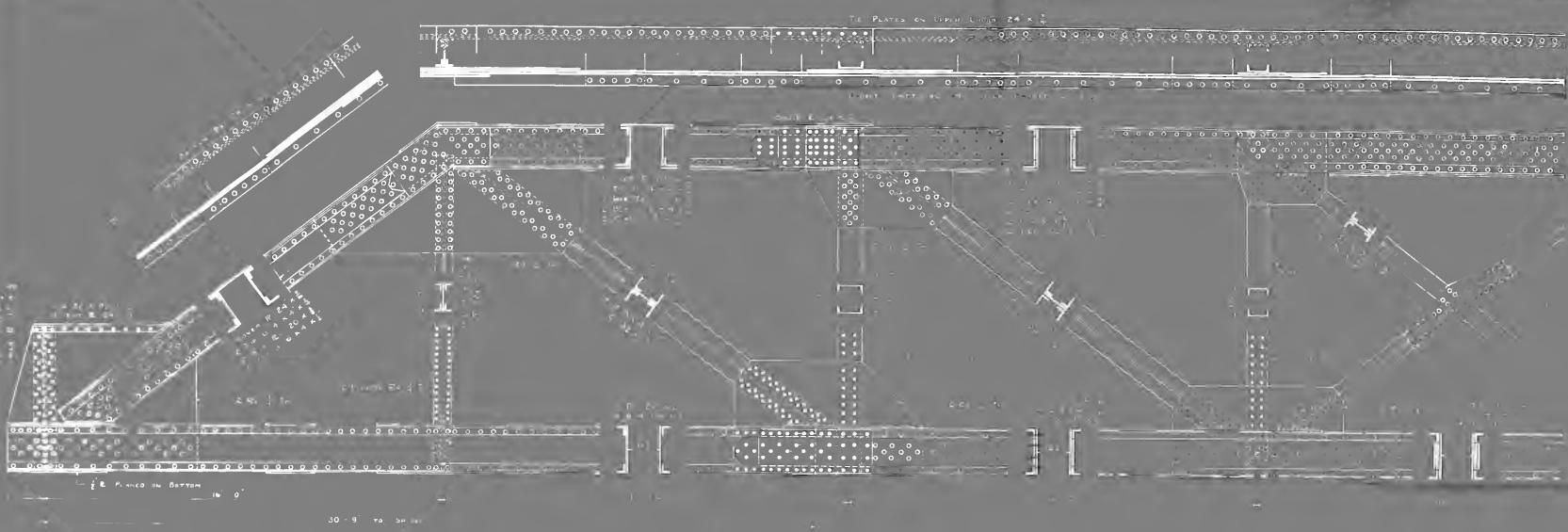
Plate I

Nov '20

Scale $\frac{1}{2}$

Appended.





12-O-SIDE TWIN PONY TRUSS
CLEARANCE LINE
FLOOR BEAM

ARMOUR INSTITUTE of TECHNOLOGY
Engineering Department
BRIDGE DESIGN
Plate I
Nov. 20
S. S. Appleton





